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Central Adriatic Geology and Fishing

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ISBN 978–88–548–4494–0

I edizione: gennaio 2012

To Angela Maria

“The angel of the Lord encamps around
those who fear him and he delivers them.”
Psalm 33 (34), 7

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Introduction

Within the **marine ecosystem** there are several different relationships between fishing resources and all the materials that settle on the seabed, in the form of organic and inorganic matter. This matter can remain on the seabed, becoming subject to diagenetic transformations or be released at different moments after passing through various changes. For example, **organic matter**, once it is sedimented and buried throughout geological time, can be transformed into gas, generally methane, and have an effect below and on the seabed, on the water column, and then on the atmosphere and all living beings. Examples will be given both of this complex process, which influences sediment dynamics and also the work of Centre Adriatic fishermen, with some of the associated environmental, industrial and touristic implications.

For several years, Centre Adriatic fishermen had complained about the loss, without knowing the reason why this should be, of their fishing equipment in the Meso Adriatic Depression (MAD), where later use of echo-sounders (3.5 KHz Sub-bottom and Uni-boom profilers will find several modest pockmarks on the seabed. Subsequently, in October and November 1978, some "**strange phenomena**" were observed along the section of continental shelf off the Marche and Abruzzi coastlines. These unusual phenomena only lasted briefly and can be summarised as follows: the sinking of a fishing boat, killing two fishermen, water columns appearing of some 40 to 50 metres in height, dark masses arising from the seabed, wakes of small air bubbles spreading over the sea surface similar to trails from some invisible submarine, light red "luminous trails or lightning" travelling through the atmosphere from the sea to disappear suddenly after about 250 or 300 metres, radar unable to detect any echo, compasses out of order, etc. (see Table 4-1). Following these episodes, the fishermen interrupted their work.

Seabed depressions (pockmarks), the diapiric structures, mud volcanoes, slumping, gas seeps and the "strange phenomena" can be linked to the presence of biogenic and thermogenic gas in the marine substratum and to its natural and possible release from the seabed, through the water column to the atmosphere. The presence of this gas affects the work of fishermen, engineering operations (installation of wharf, oil rigs and platform for hydrocarbons, etc.) and tourism. These gas seepages are particularly abundant in the Adriatic Sea.

The **sediment structures** which reveal the presence of gas in the substratum and on the seabed will be described here, together with an explanation of their rising mechanisms. There is **evidence** of **biogenic** and **thermogenic gas** rising through water in the form of gas columns up to 35 metres in height and 5 metres in width from documentary records, generally obtained by high resolution 3.5 KHz sub-bottom seismic profilers. Thermogenic gas seepage is related to the reactivation of buried **faults** and overthrust faults, which have affected and are affecting Pliocenic and Quaternary formations in the "sightings" zones. This provides a believable scientific explanation for the strange phenomena experienced by the Central Adriatic fishermen (Table 4-1).

Finally, this study suggests a **zoning** of the areas influenced by the presence of gas deriving from different geo- sedimentary deposits and seismic activity, in order to help fishermen continue their work. Furthermore, this zoning, and a better general understanding of the sea, would permit fishermen and those on all other vessels travelling along the continental shelf, to be at sea, no longer subjected to "strange phenomena", but with a deeper understanding of their working environment.

Chapter I

Biologic and environmental setting

The **marine ecosystem** is an extremely complex, vast and well-constructed environment, where chemical, physical, sedimentological and geologic conditions tend to harmonise, through the continuous exchange and communication between all its different parts. This means that, when addressing any marine problem, a solution must take in all the components of oceanography, i.e. biology, chemistry, geology and physics (listed in strict alphabetical order).

The temporary **variations** in both the catching and the stranding of many fish species that occurs in all the seas worldwide can be traced to numerous factors, specifically those typical of the different time and space scales (Belveze and Erzini, 1983; Southward et al., 1988; Laevastu, 1993). In recent years, special attention has been paid to **global climate changes** and resulting negative effects, such as an increase in carbon dioxide, have been linked to a human influence. Without negating this influence, it must be remembered that climate fluctuations and their effect over the environment have always existed on Earth throughout the last 644 million years, and specifically, since the documented presence and evolution of life during the Phanerozoic Eon. For an example, see Fig. 1 for the climate variations in Western Greenland (A1) and Southern Greenland (B) registered between 1870 and 1956 (Herman, 1967).

Ice core studies of Greenland provided a temperature data pattern from 1861 to 1998, from which temperatures could be predicted for the period from 1999 to 2099, including standard deviation errors. Similarly, a model of atmospheric circulation from 1899 to 1999

provided the data on which to make a forecast for the years 2000 to 2099, with standard deviation errors (Klyashtorin, 2001).
Paleoclimatic studies of a Vostok ice core from the Antarctic, up to 740,000 years old, has highlighted that we could have a climate in the future similar to the present one without human intervention (EPICA, 2004).

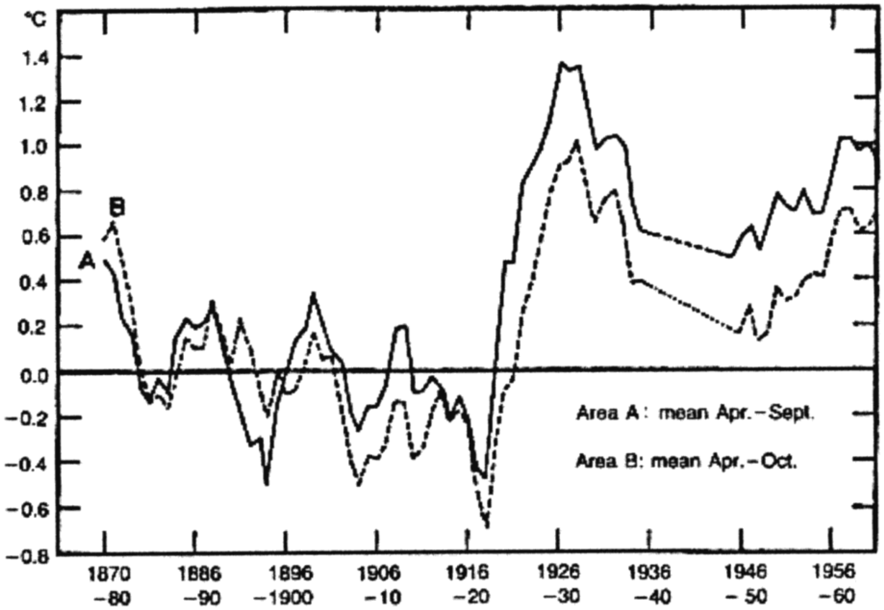

Figure 1-1. Anomalies in temperatures over the sea surface. Curve A represents Western Greenland and curve B Southern Greenland. The data used for the representation have been averaged out every five years (from Herman, modified, 1967).

Climate variations, in their turn, can have effect on fishing. Fishing is subject to wind conditions and, therefore, to wave motion, ice at high latitudes and rain. To study this, Belveze and Erzini (1983) compared fish caught, expressed in thousands of tons, to the quantity of rain, expressed in metres, for the period between 1947 and 1981.

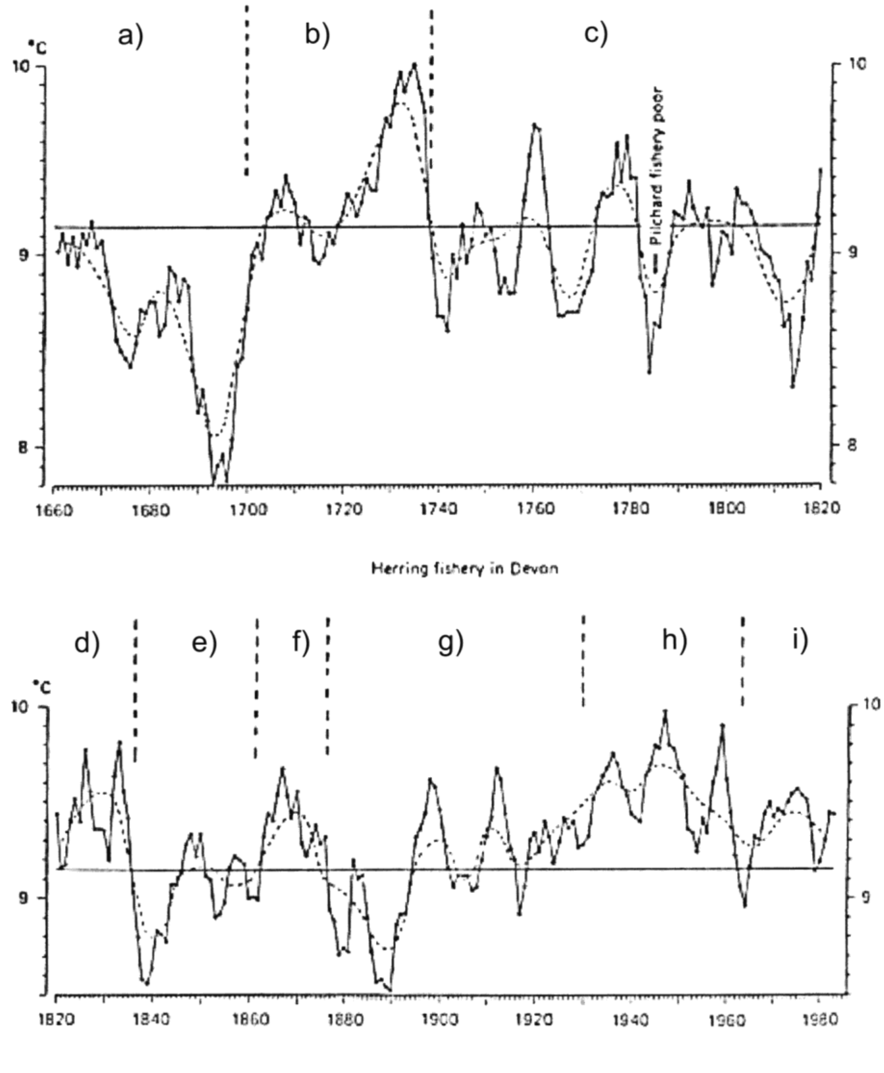

Figure 1-2. Data of fish caught in the period 1650 to 1984 compared to the average temperatures in Central England. Temperatures are represented as the average of the values registered every five years for the continuous line and every eleven years for the broken line, respectively, and therefore the latter appears more rounded than the former. The horizontal line represents the average value for the whole period. Species of fish considered are: pilchard and herring (from Southward et al., modified, 1988).

In detail, the following are the evaluations of catches relative to temperature, for the different decades.
a) From 1660 to 1710, during relatively low average temperatures (min 7.80°C, max 9.20°C), pilchard fished only in western Cornwall with consequent low exports; increased trade in herring and herring export from Cornwall.
b) From 1710 to 1739, during high average temperatures (from 8.95°C to 10.00°C), pilchard fished at Dartmouth and in SE Cornwall.
c) From 1739 al 1820, during median temperatures (from 9.70°C to 8.30°C), few or no pilchard fished in Devonshire and fluctuating fishing in autumn – winter in Cornwall.
d) From 1820 to 1837, during high average temperatures (from 9.15°C to 9.80°C), autumn fishing of pilchard in Cornwall and in Bigbury Bay.
e) From 1837 to 1862, during low average temperatures (from 8.55°C to 9.35°C) pilchard fishing failed in Devonshire.
f) From 1862 to 1878, during high average temperatures (from 9.70 to C 9.15°C), herring fished in Devonshire and pilchard in Lyme Bay.
g) From 1878 to 1931, for median temperatures (from 8.52°C to 9.70°C), herring fished occurred in Devonshire.
h) From 1931 to 1964, during high average temperatures (from 8.95°C to 10.00°C), drop in herring caught in Devonshire, summer abundance of pilchard off Plymouth, of pilchard in Lime Bay, and scarce winter catch of pilchard in SE Cornwall.
i) From 1964 to 1980, during temperatures from medium (8.95°C) to medium-high (9.95°C) pilchard left southern Devonshire in summer; winter fishing of pilchard and herring in eastern Devonshire.

Over 25 years, from 1973 to 1998, changes to the quantitative and qualitative composition of the Adriatic ichthyofauna might be related to **oceanographic changes**, particularly to long-term temperature changes (Dulćić J. and Grbec B., 2000). Elsewhere, unusual occurrences in marine life have been correlated to changes in the marine environment (Mearns, 1988) and changes in fish groupings may be the first indication of an environmental shift (Stefen et al., 1988).

It has been showed that enhanced hydroclimatic conditions in the NW Mediterranean can favour the increase in fish and invertebrate stocks and suggest a link between the Mediterranean species caught and local (river discharge, wind conditions) or global (North Atlantic oscillations - NAO) (Lloret et al., 2001) environmental conditions.

Over the last few decades, from 1976 to 1998, the **collapse** of the **anchovy** stock, in 1986 to 1990, was the most important event occurring in the Adriatic Sea, one the most productive systems in the Mediterranean. Over the same period, surface temperature, average and per year, was between 1.0°C and 1.5°C less than the previous and the subsequent periods. Productivity in the population of small pelagic fish has been related to variations in temperature, and, in particular, this drop in temperature may have affected the survival of anchovy larva (Azzali et al. 2002). Still remaining in the Adriatic Sea, the mean surface spring temperature has been connected with the biomass of iuvenile anchovy the same year and with adult anchovy biomass the following (Leonori et al., 2007).

There is a clear **link** between fish **production** and **climate**, so projecting future climate changes is evidently meaningful. Climate can be used to forecast commercial fish yields and to estimate general changes in biological production on a global scale. Therefore, it is important to maintain databases containing routine fisheries' data and long-term climate indicators, in order to track these critical processes (Klyashtorin L.B., 2001).

Leaving the description of the relationships existing between ichthyic resources and biological, chemical and physical aspects of the seabed to later, it will now consider the different bonds between **fishing species** and **gas** seeping from the seabed under different conditions. These relationships depend on the union between organic and inorganic matter while being transferred under suspension through the water column, the sedimentation process in accumulation zones, the transformation of elements, principally organic matters, on the seabed and substratum and when they are released after having been transformed into gas. Analyses of sediments and experiments in the field and in laboratory have demonstrated that the accumulation areas of fine sediments are also those that show higher concentrations of nutritive elements and heavy metals. Here, it is the sediments that can play an "active" role in the balance within the environment, since they can release relatively significant quantities of these elements into the water above (Curzi and Giordani, 1989). It follows that there is a need for accurate surveys on present and Holocene dynamics of sedimentation in the Adriatic Sea, considering that the latter has remained practically unchanged over the last 6,000 years (Curzi and

Tomadin, 1987). However, studying the transformation of organic matter into gas and its subsequent release into the water column and then into the atmosphere, and processes such as bioturbation and re-suspension, involves a shorter time resolution.

There is a very strong **relationship** between **benthic species** and **sediment** types. Razor shells (*Ensis, ensis*), for example, live in sandy sediments, clams (*Venus gallina, Tapes decussatus*) thrive in sandy and silty sediments, soles (*Solea solea L.*) can be found in silty- clayey sediments and scampi (*Nephrops norvegicus*) in clayey-sandy sediments or in cohesive clayey sediments with a high carbonate content, provided there is a good cohesion, or at least such as to enable them to construct the tunnels in which they live (Artegiani et al., 1979; Curzi et al., 1980).

In the past, Middle Adriatic fishermen at work experienced events that were incomprehensible for the time, such as the so-called "*lu sciò*", at the time when *paranze* (wooden fishing boats with a Latin sail) were still in use, or the loss of fishing equipment in the Meso Adriatic Depression or Jabuka Trench (called by the fishermen *Fossa di Pomo* or *funnalitte*) in past decades and, recently those "**strange phenomena**" noticed in October and November 1978 along the Marche and Abruzzi coastlines and the unfortunate loss of a small fishing boat offshore from the mouth of River Tronto.

For a long time, at least since last century, "***lu sciò***" troubled the normally fearless fishermen from San Benedetto del Tronto. Initially appearing as a compact mass of clouds, in their eyes it seemed to be a multitude of souls, a whirling column of the avenging dead, a "sword of God", joined by the spirits of living enemies. Today "*lu sciò*" is commonly known as "*meterorico scione"*, a water spout, a wind and water-whirl. Maybe an explanation for this legend can be found on board a *paranza* caught by the "*sciò*" in the open sea, under extreme weather conditions, with sea or air trumpets and high seas, compounded by the difficult physical conditions encountered when facing rough weather on board out-dated boats, all contributing to send a fisherman mad. Cursing and shouting meaningless words and waving a large knife, he tried to kill what he saw as a fast, fleeting dragon dragging men and objects behind it, thinking he could see the souls of the dead and the faces of enemies who wanted to suck him in (Caselli, 1980).

"Satisfactory **explanations** have been given to both historical and recent problems involving the work of the fishermen. "*Lu sciò*" has been explained as an air spout. The loss and damage of fishing equipment, in the Meso Adriatic Depression have been linked to sudden "depressions on the seabed" (pockmarks), with evidence provided by modern high resolution geophysical instruments, and are produced by gas rising from the sub-bottom.

The **strange**, short-lived **phenomena** occurring along the Marche-Abruzzi coastline will be described later, and can be summarised as follows: water columns rising up to 50 metres high, dark masses coming up from the seabed, wakes of small air bubbles spreading over the sea surface similar to trails coming from some invisible submarine, light red "rockets" travelling through the atmosphere from the sea and disappearing suddenly after 250 or 300 metres, radar unable to detect any echo, compasses out of order, etc.

After carrying out several ecological-marine studies, the strange phenomena, such as depressions on the seabed, have been linked to the **presence** of **biogenic** and **thermogenic gas** in the sea sub-bottom. The Central Adriatic Sea is extremely rich in these kinds of gasses, which rise into the atmosphere through the water column.